

555,000

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
18 November 2004 (18.11.2004)

PCT

(10) International Publication Number  
**WO 2004/098750 A1**

(51) International Patent Classification<sup>7</sup>: **B01D 53/22**,  
69/02, C01B 3/38, 13/02

(21) International Application Number:  
PCT/GB2004/001787

(22) International Filing Date: 28 April 2004 (28.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0310281.1 3 May 2003 (03.05.2003) GB

(71) Applicant (for all designated States except US): **ROBERT GORDON UNIVERSITY** [GB/GB]; Schoolhill, Aberdeen AB10 1FR (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GOBINA, Edward**

[GB/GB]; c/o Robert Gordon University, Schoolhill, Aberdeen AB10 1FR (GB). **OLSON, Susanne** [BR/GB]; Robert Gordon University, Schoolhill, Aberdeen, AB10 1FR (GB).

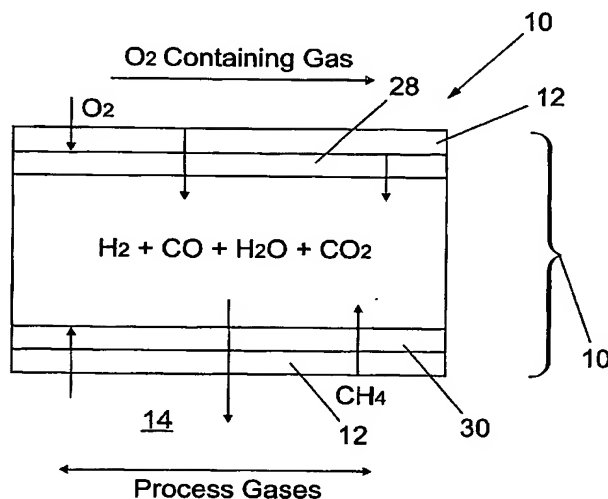
(74) Agent: **MURGITROYD & COMPANY**; 165-169 Scotland Street, Glasgow G5 8PL (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: A MEMBRANE APPARATUS AND METHOD OF PREPARING A MEMBRANE AND A METHOD OF PRODUCING HYDROGEN



(57) Abstract: The present invention discloses a method, apparatus and method of manufacturing an apparatus; all to produce hydrogen gas, particularly synthesis gas. Preferred embodiments of the invention include an alpha alumina membrane which has been treated with a TiO<sub>2</sub> wash coat on one side and has an active gamma alumina layer on an opposite side. A metal catalyst, preferably rhodium, is deposited within the pores of the alumina. Oxygen travels through the membrane and is activated before contacting methane on the other side of the membrane and forming synthesis gas through partial oxidation of the methane. Embodiments of the invention have a number of benefits including the high conversion rate of oxygen (100 %), the separate feed streams of methane and oxygen which allow for optimal ratios to be used without danger of explosion, and the opportunity to vary the feed rates without changing the products

formed. Normally gaseous hydrocarbons recovered from remote oil wells (e.g. offshore oil wells) can thus be converted to synthesis gas and then to normally liquid hydrocarbons via a Fischer-Tropsch type reaction. The normally liquid hydrocarbons are easier to transport away from the remote oil well than normally gaseous hydrocarbons.

WO 2004/098750 A1



GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— with international search report

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*